

MEASURES FOR DETERIORATION OF BRIDGE TO MINIMIZE LIFE CYCLE COST

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ABSTRACT

We West Nippon Expressway Company Limited (NEXCO-WEST) have been conducting various bridge maintenance projects for safety and reliability since have a lot of aged bridges. The bridge maintenance projects are carried out while evaluating bridge conditions based on detail inspections enforced every 5 years and implementing selected appropriate repair or strengthen work within appropriate period.

In spite of our planned measure for anti-aging, since our expressways are so old, the average age is 23 years and 22% of all are more than 30 years old, and because of increased heavy traffic and chemical spreading for snow and ice control, the deterioration especially on aging slab is getting worse and worse.

As measures for slab aging, NEXCO-West has implemented partial slab replacing or concrete overlay; however, in order for minimization of life cycle cost (LCC), whole slab replacing by utilizing pre-stressed concrete (PC) slab that has higher quality and durability is being carried out.

NEXCO-West is going to evaluating the effectiveness of the measure, and also trying to establish optimal anti-aging measures with minimum LCC by positively adopting new methods and technology.

1. INTRODUCTION

Expressways Japan are owned by Japan Expressway Hold and Debt Repayment Agency (JHHDRA) after Japan Highway Public Corporation was privatized in 2005, and expressway companies including NEXCO-West have been conducting operation and maintenance of those expressways.

NEXCO-West operates over 3,300km expressways in west region of Japan, and the annual toll

income is around 600 billion JPY. The expressways include about 3,000 bridges, and 660 of them that is 22% are older than 30 years, and such bridges are increasing year by year.

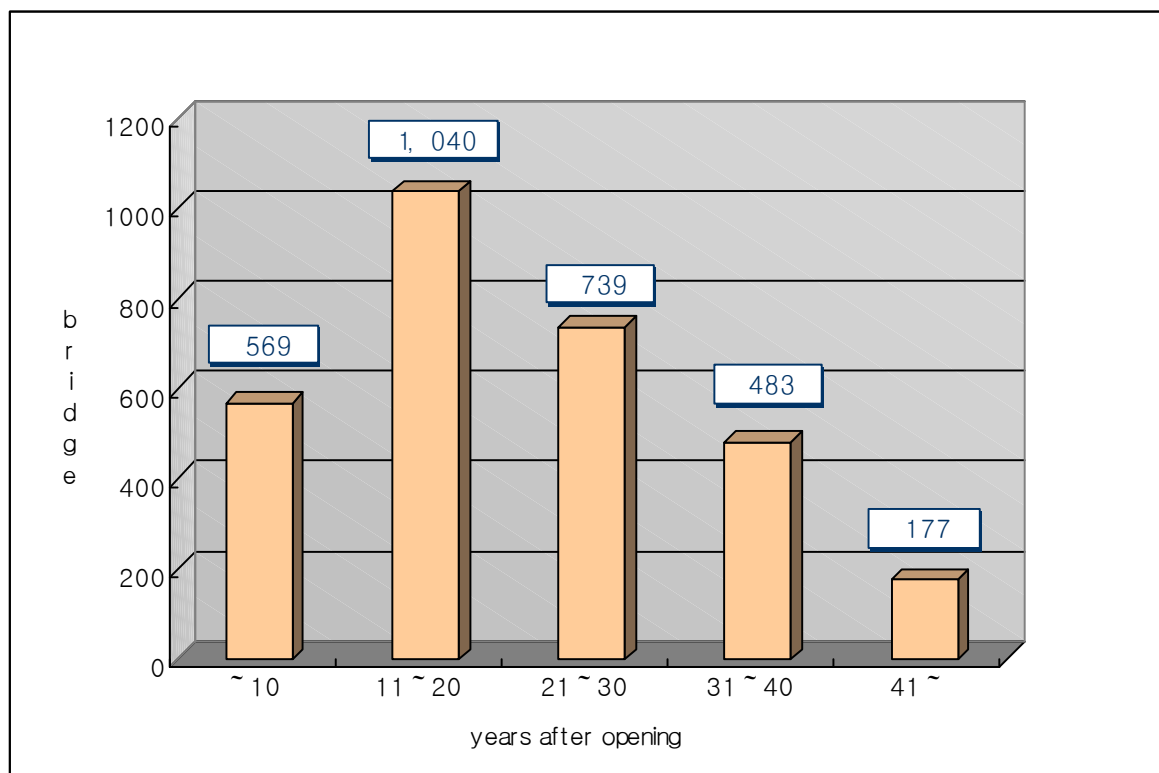


Figure –1 Volume of bridges

2. STRATEGY OF BRIDGE MAINTENANCE PROJECT

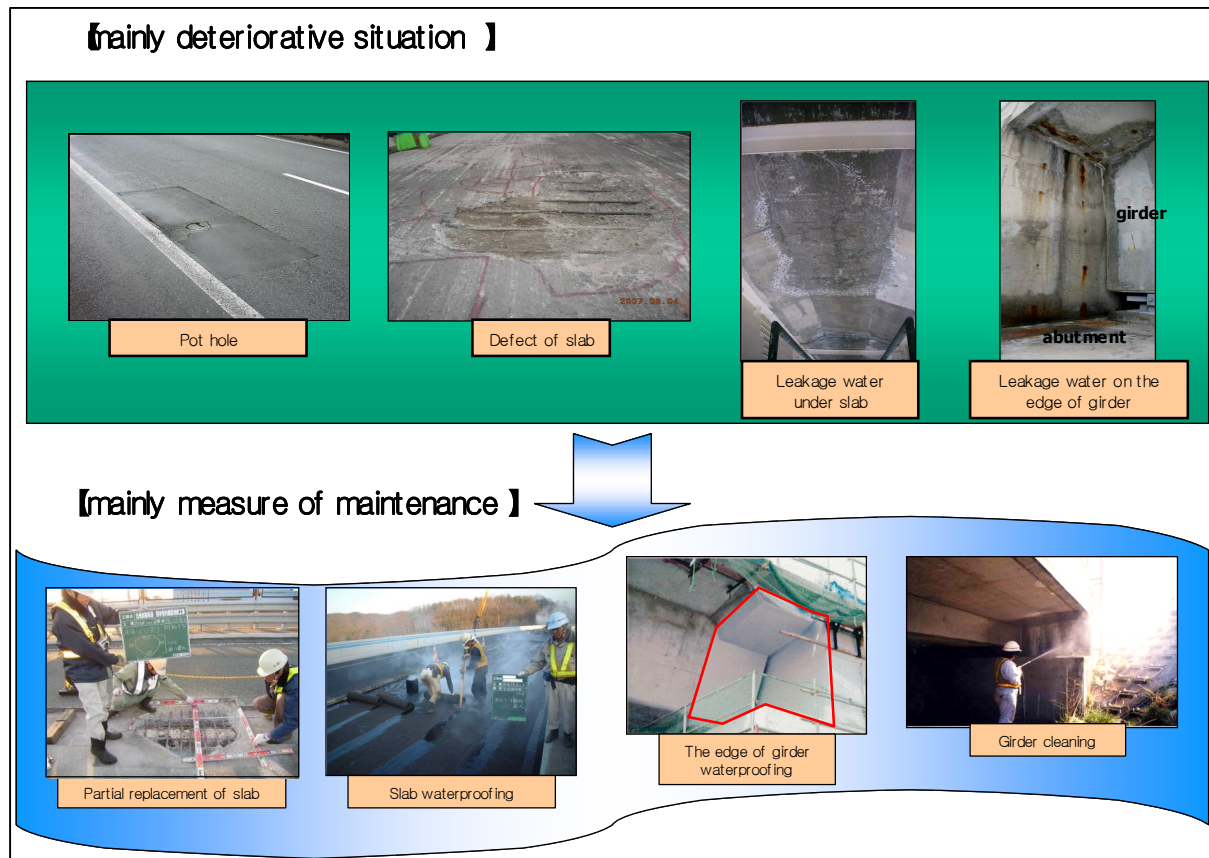
1) PARTIAL REPAIR OF DEFECTS AND MEASURES OF PREVENTIVE MAINTENANCE

According to our experiences, major deterioration caused by aging can be seen on slab or edge of girder; therefore, as measures for that, NEXCO-West is implementing partial replacing, slab waterproofing, edge of girder waterproofing, cleaning of girder to remove deicing salt, and so on as seen in picture.1, and the annual project cost in 2009 is almost 7 billion JPY.

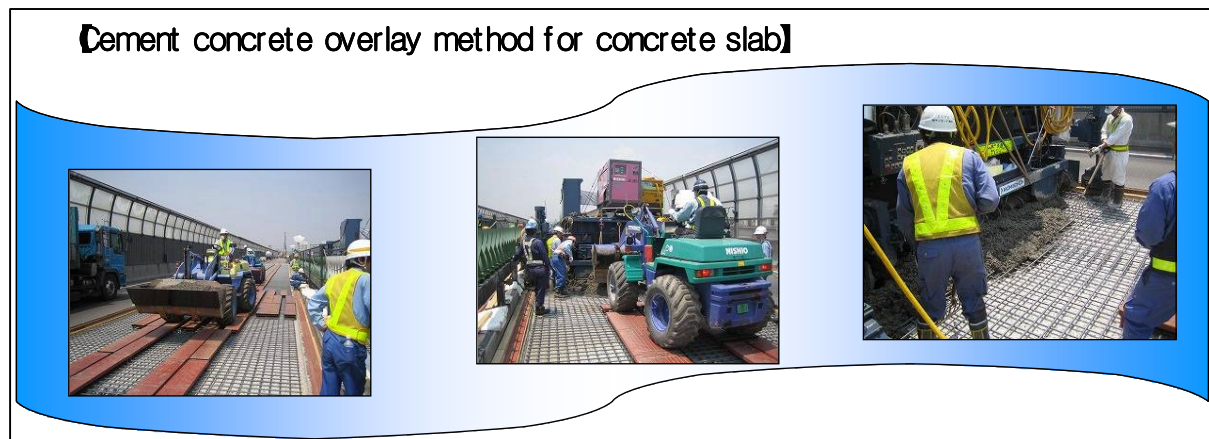
2) IMPROVING LOAD-BEARING PERFORMANCE OF SLAB TO PROLONG LIFE CYCLE

On expressways with enormous heavy traffic like MEISHIN, on the other hand, the deterioration speed is so rapid that partial replacing is not enough to secure good and stable condition, and some bridges repeat to deteriorate again and again in relatively short period ever after restoration.

For those bridges such as TAKEDA viaduct on MEISHIN expressway, in order to improve durability of slab, cement concrete overlay that makes the slab thicker is adopted as shown in picture.2.



Picture.1 Deteriorative situation and measure of repair and reinforcement



Picture.2 Cement concrete overlay method for concrete slab

3) IMPREMENTING DRASTIC MEASURES

Since bridges that require some repair work will increase more and more, in order to minimize LCC, NEXCO-West is planning of adopting reconstruction with PC-slab. AOTSU bridge on CHUGOKU expressway whose slab has significantly deteriorated because of aging and chemical spreading was selected as a pilot project of reconstruction using PC-slab. The project started last October with 18

month of duration, and old reinforced slab will be replaced to new PC-slab soon.

Figure-2 shows comparison of long-term cost estimation between ordinary maintenance method such as partial replacement and drastic method like PC-reconstruction.

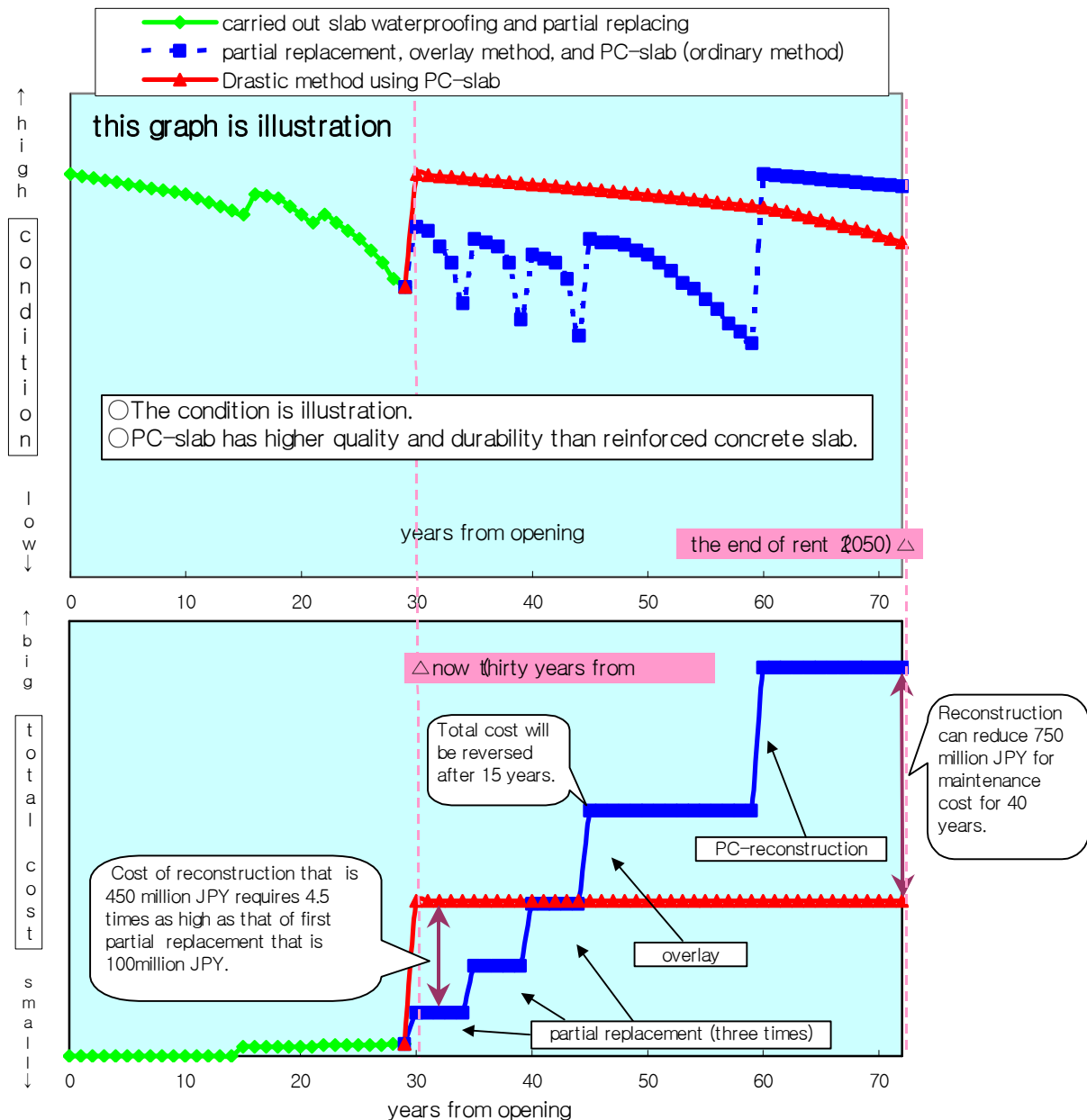


Figure -2 Competition of LCC

As for initial investment, cost of reconstruction that is 450 million JPY requires 4.5 times as high as that of partial replacement that is 100 million JPY. However, as for LCC, since reconstruction improves bridge life, it can reduce 750 million JPY for maintenance cost in 40-year period. Also, once reconstruction is conducted, the bridge can be maintenance-free that means there will be few traffic regulation or construction work, and costumers can be satisfied with comfortable driving.

3. CONCLUSION

NEXCO-West has a lot of old bridges that are still deteriorating year by year because of heavy traffic, chemical spreading, and aging itself, and some of them actually need drastic reconstruction method. Although the method is fairly effective, it also requires long-term traffic regulation; therefore, in order to secure the functions of network even during such major reconstruction work, NEW MEISHIN expressway, now under construction, is significantly needed.

NEXCO-West has been inspecting bridges in detail, evaluating those conditions correctly, and selecting and applying most appropriate repair method. Because conditions of bridges are different each by each, it is necessary to prepare several alternative methods, and the most important thing is to minimize LCC by implementing maintenance method for with optimal method within optimal period.

NEXCO-West will continue to study to find the optimal maintenance method for minimum LCC by evaluating the effectiveness of the maintenance projects and making sure of more effective developing technology.

Appendix

AOTSU bridge as shown in figure-3 on CHUGOKU expressway is almost 30 years old, and its slab has deteriorated because of aging and chemical spreading for snow and ice control. To repair the bridge, slab waterproofing, partial patching, preventive measures for falling fragment, and pavement patching, preventive measures for falling fragment, and pavement patching were implemented. Those measures as shown in picture-3 were quite effective to prolong its lifetime.

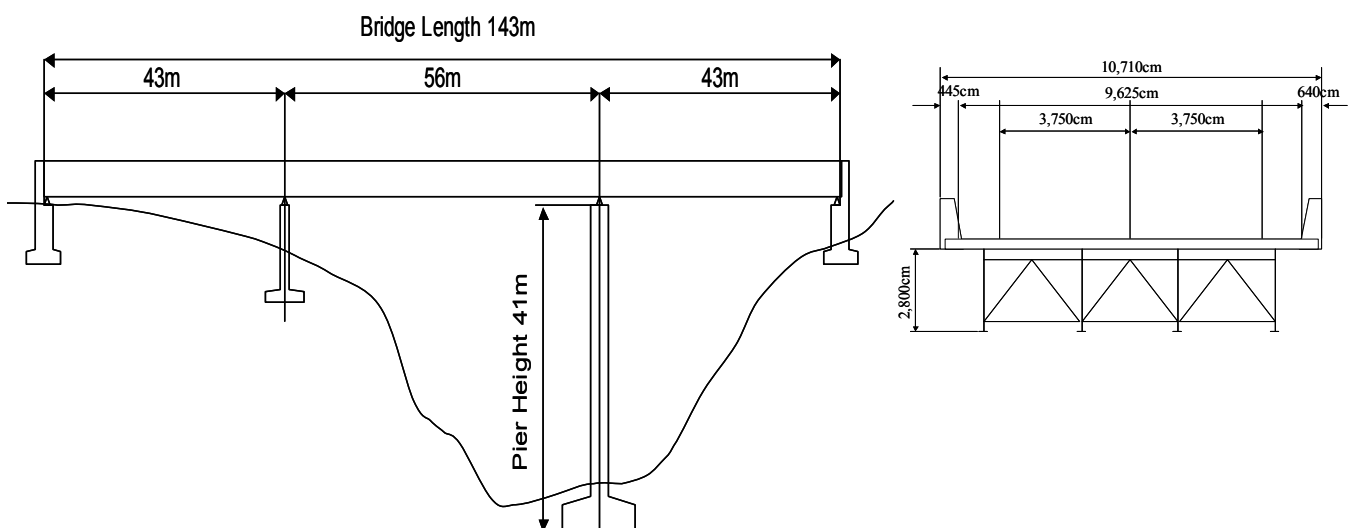


Figure.3 AOTSU Bridge General View



Picture.3 Condition of AOTHU Bridge

However, since potholes still appear even after the repair work because of basically deteriorated slab, reconstruction with PC-slab was selected as a pilot project. The project started last October with 18 month period, and old reinforced slab will be replace to new PC-slab made in the factory as shown in picture-4 and figure-4.



replace deteriorative slab



reconstruction with PC-slab

Picture.4 Construction work view